

WHAT IS CLAIMED IS:

1. In a drilling apparatus for performing underground boring, said apparatus including a drill rig and a boring tool which is configured for moving through the  
5 ground to form an underground bore, said boring tool including means for emitting a locating signal, a locator/control arrangement comprising:

a) a portable device for generating certain information about the position of the boring tool in response to and using said locating signal, said portable  
10 device also including means for generating command signals in view of said certain information and for transmitting said command signals to said drill rig; and

b) means located at said drill rig for receiving said command signals whereby the command signals can be used to control the boring tool.  
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2. The locator/control arrangement according to Claim 1 wherein said command signals include steering commands for use in steering said boring tool.

3. The locator/control arrangement according to Claim 1 wherein said  
20 command signals include roll orientation commands for use in controlling the directional orientation of the boring tool.

4. The locator/control arrangement according to Claim 1 wherein said command signals include advance, retract and stop commands for indicating that the  
25 boring tool should be moved forward, backward or held stationary.

5. The locator/control arrangement according to Claim 1 wherein said portable device includes a joystick arrangement positioned for actuation by an operator of the locator/control arrangement such that the operator may cause said command signals to be transmitted from the portable device.

6. The locator/control arrangement according to Claim 5 wherein said joystick arrangement is configured for use in generating straight, advance, retract and stop commands such that the boring tool should move forward, backward or be held stationary.

7. The locator/control arrangement according to Claim 1 wherein said portable device includes display means configured for displaying certain information regarding the control of the boring tool to an operator.

8. The locator/control arrangement according to Claim 7 wherein said boring tool is configured for transmitting roll data, as part of said locating signal, and wherein said portable device includes means for receiving said roll data and for using said roll data to determine a detected roll orientation of said boring tool which is related to steering the boring tool, said display means being configured for displaying the detected roll orientation of the boring as part of said certain information.

9. The locator/control arrangement according to Claim 7 wherein said display means displays a desired roll of the boring tool as part of said certain information.

10. The locator/control arrangement according to Claim 9 wherein said portable device includes a joystick arrangement positioned on said portable device adapted for actuation by an operator of the locator/control arrangement such that the operator may issue commands to steer in a particular direction, advance or retract the boring tool and wherein said certain information includes a desired roll orientation of the boring tool based on the operator's actuation of said joystick arrangement.

11. The locator/control arrangement according to Claim 10 wherein said boring tool is configured for transmitting roll data as part of said locating signal and wherein said portable device includes means for receiving said roll data and for using said roll data to determine a detected roll orientation of said boring tool, said certain information including the detected roll orientation of the boring tool such that the operator of the portable device can compare the desired roll orientation with the detected roll orientation.

12. The locator/control arrangement according to Claim 10 wherein said display means includes a clock face upon which said detected roll orientation and said desired roll orientation are displayed.

13. The locator/control arrangement according to Claim 12 wherein said clock face includes a center position which represents boring straight ahead such that the boring tool rotates.

14. The locator/control arrangement according to Claim 1 wherein said means for receiving said command signals at the drill rig includes means configured for displaying said command signals to an operator stationed at the drill rig.

5           15. The locator/control arrangement according to Claim 14 wherein said portable device is configured for selectively generating a steering command as one of said command signals for use in controlling the directional orientation of the boring tool and wherein said display means at the drill rig is configured for displaying the steering command generated by the portable device.

10           16. The locator/control arrangement according to Claim 14 wherein said portable device is configured for generating advance, retract and stop commands as said command signals for indicating that the boring tool should move forward, backward or be held stationary and wherein said display means at the drill rig is  
15           configured for displaying the forward, backward and stationary commands generated by the portable device.

20           17. The locator/control arrangement according to Claim 1 wherein said means at the drill rig for receiving said command signals includes means configured for aural indication of said command signals to an operator stationed at the drill rig.

          18. The locator/control arrangement according to Claim 1 wherein said means for receiving the command signals at the drill rig includes means responsive to said command signals configured for actuating one or more control assemblies for directly

controlling the motion of said boring tool using said commands generated by the portable device.

19. The locator/control arrangement according to Claim 1 further comprising:

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c) detection means at said drill rig for monitoring particular operational parameters which affect the performance of a utility to be installed in the underground bore, the drill rig and/or the boring tool;

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d) means located at said drill rig for transmitting certain data regarding said particular operational parameters from the drill rig to said portable device; and

e) means forming part of said portable device for indicating said certain data.

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20. The locator/control arrangement according to Claim 19 wherein at least one of said particular operational parameters is capable of violating a minimum or maximum predetermined value and wherein said means for transmitting said certain data to the boring tool is configured for transmitting, as part of said certain data, a warning to said portable device that said predetermined value has been violated for indication by said indicating means.

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21. The locator/control arrangement according to Claim 20 wherein said indicating means includes means for providing an audio and/or visual indication in response to receipt of said warning.

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22. The locator/control arrangement according to Claim 21 wherein said particular operational parameter is force with which the boring tool is being pushed forward by the drill rig such that a maximum push value is established beyond which the boring tool will be damaged and wherein said indicating means at said portable device provides indication of violation of the maximum push value.

23. The locator/control arrangement according to Claim 20 wherein said boring tool is attached to and moved by a drill string having one minimum bend radius and extending from the drill rig and a utility to be installed includes another minimum bend radius and wherein said detection means at the drill rig includes means for monitoring curvature of the underground bore being formed by the boring tool as one of said particular operational parameters and for comparing a selected one of either the minimum bend radius of the drill string or the minimum bend radius of the utility with the curvature of the underground bore, and wherein said indicating means in the portable device is configured for indicating that the selected minimum bend radius is being violated.

24. The locator/controller arrangement according to Claim 23 wherein the selected minimum bend radius is the <sup>greater</sup> ~~lesser~~ of the minimum bend radius of the drill string or the minimum bend radius of the utility and said indicating means at said portable device provides indication of violation of the <sup>greater</sup> ~~lesser~~ minimum bend radius.

25. The locator/control arrangement according to Claim 21 wherein said boring tool uses drilling mud provided from said drill rig and wherein said indicating means at

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said portable device is configured to provide indication of an absence of drilling mud at the boring tool.

26. The locator/control arrangement according to Claim 19 wherein said  
5 particular operational parameter is push force with which the boring tool is being  
pushed forward by the drill rig and said portable device includes a joystick arrangement  
positioned on said portable device adapted for actuation by an operator of the  
locator/control arrangement such that the operator may move the joystick in a  
direction which issues an advance command to advance the boring tool and wherein  
10 said indicating means includes feedback means in communication with said joystick  
which resists movement of the joystick by the operator in the advance command  
direction in direct proportion to increasing push force.

27. In a drilling apparatus for performing underground boring, said apparatus  
15 including a drill rig which operates a boring tool that is configured for moving through  
the ground to form an underground bore, said boring tool including means for emitting  
a locating signal, a method of controlling the boring tool comprising the steps of:

a) providing a portable device for generating certain information about  
20 the position of the boring tool in response to and using said locating signal, said  
portable device also including means for generating command signals;

b) in view of said certain information, generating said command signals  
and, thereafter, transmitting the command signals to said drill rig from the portable  
25 device; and

c) using the command signals at said drill rig for controlling the boring tool.

5           28. The method according to Claim 27 wherein said command signals include a steering command and wherein the step of using the command signals includes the step of steering said boring tool using the steering command.

10           29. The method according to Claim 27 wherein said command signals include a roll orientation command and wherein the step of using the command signals includes the step of changing the directional orientation of the boring tool according to the roll orientation command.

15           30. The method according to Claim 27 wherein said command signals include advance, retract and stop commands and wherein the step of using said command signals includes the steps of moving the boring tool forward in response to the forward command, moving the boring tool backward in response to the retract command and holding the boring tool stationary in response to the stop command.

20           31. The method according to Claim 27 wherein said portable device includes a joystick arrangement positioned for actuation by an operator of the portable device and wherein said step of transmitting the command signals to the drill rig is performed responsive to actuation of said joystick arrangement by said operator in view of said certain information.



32. The method according to Claim 27 wherein said step of using said command signals at the drill rig includes the step of visually and/or aurally indicating the command signals to a drill rig operator.

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33. The method according to Claim 27 wherein said step of using said command signals at the drill rig includes the step of actuating one or more control assemblies for directly controlling the motion of said boring tool using said commands generated by the portable device.

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34. The method according to Claim 27 further comprising the steps of:

d) monitoring particular operational parameters at said drill rig which parameters affect the performance of the drill rig and/or boring tool;

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e) transmitting certain data regarding said particular operational parameters from the drill rig to said portable device; and

f) indicating said certain data at the portable device.

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35. The method according to Claim 34 wherein at least one of said particular operational parameters is capable of violating a minimum or maximum predetermined value and wherein said step of transmitting said certain data to the boring tool transmits, as part of said certain data, a warning to said portable device that said predetermined value has been violated.

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36. The method according to Claim 35 wherein said indicating step includes the step of visually and/or aurally indicating said warning.

5 37. The method according to Claim 27 wherein said boring tool is attached to and moved by a drill string having one minimum bend radius and extending from the drill rig and a utility to be installed in the underground bore includes another minimum bend radius and wherein said method includes the steps of (i) selecting the minimum bend radius of the drill string or the minimum bend radius of the utility as an overall  
10 minimum bend radius, (ii) monitoring the <sup>bend radius</sup>~~curvature~~ of the underground bore as it is formed by the boring tool, and (iii) if the <sup>bend radius</sup>~~curvature~~ of the underground bore is less than said overall minimum bend radius, indicating, at the portable device, that the overall minimum bend radius is being violated.

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15 38. The method according to Claim 37 wherein the selected minimum bend radius is the <sup>greater</sup>~~lesser~~ of the minimum bend radius of the drill string or the minimum bend radius of the utility.

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